ENGINEERING CHANGE NOTICE

1. ECN 635504

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. Jim G. Field, Data Assessment and Interpretation, R2-12, 376-3753	4. USQ Required? [] Yes [X] No	5. Date 07/25/97
	6. Project Title/No./Work Order No. Tank 241-A-101	7. Bldg./Sys./Fac. No. 241-A-101	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-673, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change — 13b. Design Baseline Document? [] Yes [X] No

This ECN was generated to include additional explanatory text in the best-basis narrative, and to update the comprehensive radionuclide inventory estimates for the tank.

Rev. 0 pages included for duplicating purposes only.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[X]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Initial release of this document was deficient.

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution.

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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. J.G. Field	J G Field	8/26/97	PE		
Cog. Mgr. K.M. Hall	Kathleen M Hall	8/26/97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-A-101

Jim G. Field
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ECN-635504 UC: 2070
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Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-A-101, 241-A-101, A-101, Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-A-101. This report supports the requirements of the Tri-Party Agreement Milestone M-44-10.

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Kara [illegible] 8/26/97
Release Approval Date

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Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-673	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-A-101

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 05/27/97 on EDT-617659.	J.G. Field	K.M. Hall
0-A RS	Incorporate per ECN-635504.	J.G. Field	K.M. Hall
		J.G. Field	Kathleen M Hall
		8/26/97	8/26/97

A-7320-005 (08/91) WEF168

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-A-101, Effective May 31, 1997. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
U_{TOTAL}	<1,600	S	The saltcake inventory is 1,180 kg. Drainable liquid concentrations were less than detection limits.
Zr	<88.4	S	The saltcake inventory is 79.6 kg. Drainable liquid concentrations were less than detection limits.

Note:

[1]S = Sample-based (based on 1996 core samples, see Appendix B), M = HDW model-based, and E = Engineering assessment-based

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-A-101 Effective May 31, 1997 (Decayed to January 1, 1994). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	731	M	
^{14}C	115	M	
^{59}Ni	7.16	M	
^{60}Co	<127	S	
^{63}Ni	703	M	
^{79}Se	11.9	M	
^{90}Sr	152,000	S	
^{90}Y	152,000	S/E	Based on ^{90}Sr analysis.
^{93}Zr	58.1	M	
^{93m}Nb	42.3	M	
^{99}Tc	869	M	
^{106}Ru	0.0256	M	
^{113m}Cd	308	M	
^{125}Sb	651	M	
^{126}Sn	18.0	M	
^{129}I	1.68	M	
^{134}Cs	12.6	M	
^{137}Cs	1,250,000	S	
^{137m}Ba	1,180,000	S/E	Based on ^{137}Cs analysis.
^{151}Sm	41,900	M	

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-A-101 Effective May 31, 1997 (Decayed to January 1, 1994). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{152}Eu	16.1	M	
^{154}Eu	<466	S	
^{155}Eu	<1,700	S	
^{226}Ra	5.2E-04	M	
^{227}Ac	0.0032	M	
^{228}Ra	1.11	M	
^{229}Th	0.026	M	
^{231}Pa	0.014	M	
^{232}Th	0.12	M	
^{232}U	3.38	M	
^{233}U	13.0	M	
^{234}U	2.19	M	
^{235}U	0.087	M	
^{236}U	0.070	M	
^{237}Np	3.0	M	
^{238}Pu	5.05	M	
^{238}U	3.0	M	
^{239}Pu	181	M	
^{240}Pu	30.6	M	
^{241}Am	197	M	
^{241}Pu	352	M	
^{242}Cm	0.54	M	
^{242}Pu	0.0019	M	
^{243}Am	0.0073	M	
^{243}Cm	0.049	M	
^{244}Cm	0.40	M	

Note:

[1]S = Sample-based (based on 1996 core samples, see Appendix B), M = HDW model-based, and E = Engineering assessment-based

The feeds for evaporator campaigns 80-10 and 81-1 were non-complexed waste, reported in the 242-A Evaporator campaign reports as dilute double-shell slurry feed (Teats 1982a and 1982b). The TOC concentration for tank 241-A-101 supernatant was 10.7 g/L following evaporator campaign 80-1 and 6.75 g/L following evaporator campaign 81-1. Solid material included with samples taken 0.6 m and 1.2 m (2 and 4 ft) below the surface following evaporator campaign 81-1 was approximately 95 weight percent sodium carbonate (Jansky 1980). Hydrates of sodium carbonate have relatively low particle densities that may have led to an initial formation of a surface crust in tank 241-A-101. No significant waste transactions involving tank 241-A-101 have taken place since 1980 (Agnew et al. 1997b).

D3.3 COMPOSITION OF TANK 241-A-101 WASTE

D3.3.1 Waste Volumes

Tank 241-A-101 is unusual in that the saltcake is located above the free liquid. Two cores, each containing 19 segments 48.3 cm (19 in.) long were recovered during sampling in July 1996. Only 28 cm (11 in.) of saltcake was recovered from the top segment of core 154 and 2.5 cm (1 in.) from the top segment of core 156. This equates to an average waste height of 884 cm (348 in.) and a total waste volume of 3,622 kL (957 kgal). This confirms the waste volume of 3,607 kL (953 kgal) reported by Hanlon (1997).

The solid/liquid interface can be estimated from three data sources: 1) a March 16, 1996 gamma scan; 2) the location of the highest temperature in the tank (expected to be located near the solids liquid interface due to the insulating effect of the saltcake); and 3) the core segments that contained any drainable liquid and the color difference between solids extruded from core samplers. The estimates are summarized in Table D3-1. The predicted average interface is predicted to be 4.72 m (15.5 ft) from the bottom of the tank, equivalent to 1,925 kL (508.5 kgal) of liquid waste after subtracting the 11 kL (3 kgal) sludge heel.

Table D3-1. Determination of Solid/Liquid Interface in Tank 241-A-101.

Method	Estimated Interface Location (from Bottom of Tank)
1996 gamma scan - riser 19	4.57 - 4.87 m (15 - 16 ft)
Temperature - thermocouple 9	4.67 - 5.28 m (15.33 - 17.33 ft)
Core sample 154, segment 10	4.34 - 4.82 m (14.25 - 15.82 ft)
Core sample 156, segment 10	4.34 - 4.82 m (14.25 - 15.83 ft)
Predicted average interface	4.72 m (15.5 ft)

This calculated liquid volume should not be used with the mean drainable liquid concentrations calculated in Appendix B because the samples were extruded at 23.3 to 25.6 °C [74 to 78 °F] and the temperature in the tank bottom averaged 62.8 °C [145 °F].

Much of the solid material extruded with the lower cores likely crystallized in the sampler. The solids in the lower cores were noted to be white rather than the gray color seen in the saltcake layer (Steen 1997). The retained gas samples taken from the bottom of the tank were X-rayed immediately after removal from the tank and were found to be homogeneous (Shekarriz et al. 1996); however, this testing does not rule out the presence of small particles. The tank waste represented by the bottom 9 core segments likely does not contain a large fraction of solid material at the actual waste temperatures.

The pumpable liquid volume reported by Hanlon (1997) does not agree with the volumes calculated from the interface location. The Hanlon (1997) pumpable liquid fraction for tank 241-A-101 was updated to 1,669 kL (441 kgal) in June 1996 based on the new liquid fraction estimates (50 percent, Brown 1996). The pumpable liquid in tank 241-A-101 would be at least 15 percent higher than calculated by Brown (1996) based on the volume of liquid below the interface (1,925 kL [508.5 kgal]). Additional pumpable liquid is likely present in the saltcake layer as at the actual tank waste temperatures (as drainable interstitial liquid). The Hanlon (1997) interstitial liquid volume of 1,563 kL (413 kgal) is also incorrect because the volume of the saltcake layer is only 1,671 kL (441.5 kgal).

The liquid fraction corresponding to the temperature of the sample extrusion and sample analyses can be calculated from the core sample extrusion data (see Table D3-2).

Table D3-2. Extrusion Data for Tank 241-A-101 Core Samples. (2 Sheets)

Core	Segment	Solid Material (g)	Drained Liquid (g)	Total Sample (g)
154	1 (top)	256.7	0.0	256.7
154	2	388.9	0.0	388.9
154	3	427.5	0.0	427.5
154	4	422.3	0.0	422.3
154	5	RGS Sample		
154	6	406.2	0.0	406.2
154	7	410.5	0.0	410.5
154	8	RGS Sample		
154	9	387.3	0.0	387.3
154	10	256.4	0.0	256.4

241-A-103. Except for sodium, the saltcake in tank 241-A-102 contains higher concentrations of corrosion products and other metallic analytes, possibly because the relatively small saltcake inventory (129 kL [34 kgal]) is located on top of a sludge heel.

The HDW model A1SltCk is a global average of all A1 saltcakes. The tank 241-A-101 inventory calculated by the HDW model is actually based on tank-specific calculations performed by the supernatant mixing model (SMMA1). A comparison of the HDW model and sample-based inventory estimates is made in Section D3.5.

Table D3-3. Composition of Tank 241-A-101 Waste. (2 Sheets)

Analyte	241-A-101 Drainable Liquid - Mean Concentration (μg/mL)	241-A-101 Solid (Salt) Mean Concentration (μg/g)	241-A-102 Core Sample Composite (μg/g)[1]	241-A-103 Core Sample Composite (μg/g)[2]	HDW Model A1SltCk (μg/g)
Ag	15.2	<16.7	241	22.8	n/r
Al	44,600	24,700	23,250	16,600	31,657
As	<54.3	<97.6	n/r	n/r	n/r
B	47.1	104	14.2	22.3	n/r
Ba	<27.2	<48.8	879	573	n/r
Be	<2.71	<4.88	n/r	n/r	n/r
Bi	<54.3	<98.1	1,670	90.3	790
Ca	<54.3	233	2,590	1,715	1,197
Cd	<2.71	9.77	49.5	7.20	n/r
Ce	<54.3	<97.6	n/r	n/r	n/r
Cl	7,980	3,890	n/r	n/r	2,158
Co	<13.5	33.2	20.7	1.74	n/r
CO_3	12,700	50,000	n/r	n/r	19,289
Cr	51.2	1,790	5,795	1,530	3,826
Cu	<5.62	<11.9	80.8	12.3	n/r
F	<78.7	479	n/r	n/r	1,141
Fe	<27.2	343	13,930	349	456
K	6,580	5,190	2,815	2,535	2,186
La	<27.2	<49.0	n/r	n/r	0
Mg	<54.3	<97.6	1,385	796	n/r
Mn	<5.43	34.0	2,028	95.9	159
Mo	120	64.5	n/r	n/r	n/r
Na	217,000	206,000	187,000	208,500	232,562
Nd	<54.3	<98.1	n/r	n/r	n/r
Ni	<10.9	64.9	526	93.2	316

Table D3-3. Composition of Tank 241-A-101 Waste. (2 Sheets)

Analyte	241-A-101 Drainable Liquid - Mean Concentration (μg/mL)	241-A-101 Solid (Salt) Mean Concentration (μg/g)	241-A-102 Core Sample Composite (μg/g)[1]	241-A-103 Core Sample Composite (μg/g)[2]	HDW Model A1SltCk (μg/g)
NO_2	137,000	82,200	n/r	n/r	75,169
NO_3	136,000	203,000	178,500	113,500	263,183
OH	40,300	n/r	n/r	n/r	101,369
Oxalate	<741	10,300	n/r	n/r	0
Pb	108	<111	1,136	105	114
P as PO_4	3,330	6,520	16,046	6,645	21,059
S as SO_4	1,290	12,700	n/r	n/r	20,813
Sb	<32.6	<58.5	n/r	n/r	n/r
Se	<54.3	<98.4	n/r	n/r	n/r
Si	135	367	16,550	11,050	2,566
Sm	<54.3	<97.6	n/r	n/r	n/r
Sr	<5.43	<9.81	97.2	12.0	0
Ti	<5.43	<9.76	n/r	n/r	n/r
Tl	<109	<195	n/r	n/r	n/r
TOC	3,340	4,800	7,570	7,885	7,788
U	<271	394	9,540	1,435	2,269
V	<27.2	<48.8	n/r	n/r	n/r
Zn	8.79	19.5	52.5	54.0	n/r
Zr	<5.66	26.6	1,402	195	105
^{241}Am[4]	<3.86E-04	<0.763	0	0.118	0.0304
^{137}Cs[4]	365	202	140	202	151
^{60}Co[4]	<0.0102	<0.0416	0	0.0750	0.0367
^{154}Eu[4]	<0.0716	<0.148	n/r	n/r	0.557
^{155}Eu[4]	<0.264	<0.430	n/r	n/r	0.232
$^{239/240}Pu$[4]	<2.14E-04	n/r	2.01	0.130	0.0561
$^{89/90}Sr$[4]	0.0753	14.2	604	48.7	88.4
Total alpha[4]	<0.0154	0.0483	n/r	n/r	n/r
Total beta[4]	n/r	184	n/r	n/r	n/r

Notes:

[1]Weiss and Schull (1988a)
[2]Weiss and Schull (1988b)
[3]Radionuclide concentrations reported as of the date analyzed.
[4]Units for radionuclides are μCi/mL or μCi/g.

D3.3.3 Composition of Tank 241-A-101 Sludge

Neither of the two core samples retrieved the sludge material on the tank bottom. The bottom segment of core 154 (segment 19) was taken from riser 15. A map of the sludge distribution remaining in the tank on February 20, 1976 (ARHCO 1976) indicates that there was no sludge at this location. Additionally, the recovery for this segment was poor. The bottom segment of core 156 (also segment 19) was an RGS. No chemical analyses were made on this material.

The sludge remaining in tank 241-A-101 after sluicing in 1976 was sampled and analyzed (Horton 1976a and 1976b). The analytical results and projected sludge inventories are provided in Table D3-4. A sludge volume of 11 kL (3 kgal) was used in calculating the sludge inventory. Inclusion of the small volume of sludge in the tank inventory significantly affects the iron, silicon and ^{90}Sr inventories.

Table D3-4. Tank 241-A-101 Sludge Heel.

Analysis	Result	A-101 Inventory
Bulk density	1.36 g/cm^3	n/a
Particle density	2.78 g/cm^3	n/a
Percent water	9.1 wt%	n/a
Aluminum	9.95*M*	3,048 kg
Iron	0.5*M*	317 kg
Silicon	3.95*M*	1,260 kg
$^{89,90}Sr$	14.5 Ci/L[1]	164,300 Ci
^{137}Cs	0.272 Ci/L[1]	3,090 Ci

Notes:
[1]Average for five sludge samples.

The solids were subjected to X-ray analysis (Burch 1976) and found to contain the following species: $AlPO_4$, SiO_2, $FeAl_2SiO_5(OH)_2$, $Al(NO_3)_3 \bullet 9H_2O$ and $KAlSiO_4$.

D3.4 PREDICTED INVENTORY FOR TANK 241-A-101

The chemical and radionuclide inventory of tank 241-A-101 can be estimated from the mean laboratory analyses for the two core samples, the total waste volume (3,607 kL [953 kgal]), the volume of the sludge heel remaining after sluicing (11 kL [3 kgal]) and the calculated volumes of solid/liquid material corresponding to the temperature of the core sample extrusion/analyses (1,565 kL [413.5 kgal] of drainable liquid and 1,797 kL [474.7 kgal] of saltcake). The retained gas volume of 234 kL (61.8 kgal) was excluded from the inventory calculations. The tank inventory is the sum of the components in the sludge, liquid and saltcake. The resulting inventories are provided in Table D3-5. The inventories estimated by the HDW model (Agnew et al. 1997a) are included in the table for comparison.

Table D3-5. Estimated Chemical and Radionuclide Inventory for Tank 241-A-101. (3 Sheets)

Analyte	Sludge Layer Inventory (kg)[1]	Drainable Liquid Inventory (kg)[2]	Saltcake Inventory (kg)[2]	Sample-Based 241-A-101 Inventory (kg)	HDW Model Inventory (kg)
Ag	n/r	23.8	<50.0	<73.8	n/r
Al	3,048	69,800	73,800	146,600	136,000
As	n/r	<85.1	<292	<377	n/r
B	n/r	73.8	312	386	n/r
Ba	n/r	<42.6	<146	<189	n/r
Be	n/r	<4.25	<14.6	<18.8	n/r
Bi	n/r	<85.1	<293	<378	767
Ca	n/r	<85.1	697	<782	3,580
Cd	n/r	<4.25	29.2	<33.5	n/r
Ce	n/r	<85.1	<292	<377	n/r
Cl	n/r	12,500	11,600	24,100	24,700
Co	n/r	<21.1	99	<120	n/r
CO_3	n/r	19,900	149,600	169,400	91,300
Cr	n/r	80.2	5,350	5,430	18,400
Cu	n/r	<8.79	<35.6	<44.4	n/r
F	n/r	<123	1,430	<1,560	3,780
Fe	317	<42.6	1,030	<1,390	3,230
K	n/r	10,300	15,500	25,800	7,580
La	n/r	<42.6	<147	<189	9.78
Mg	n/r	<85.1	<292	<377	n/r

Table D3-5. Estimated Chemical and Radionuclide Inventory for Tank 241-A-101. (3 Sheets)

Analyte	Sludge Layer Inventory (kg)[1]	Drainable Liquid Inventory (kg)[2]	Saltcake Inventory (kg)[2]	Sample-Based 241-A-101 Inventory (kg)	HDW Model Inventory (kg)
Mn	n/r	<8.51	102	<110	746
Mo	n/r	187	193	380	n/r
Na	n/r	340,000	614,800	954,800	927,000
Nd	n/r	<85.1	<293	<378	n/r
Ni	n/r	<17.0	194	<211	978
NO_2	n/r	215,200	246,000	461,200	338,000
NO_3	n/r	212,400	608,200	820,700	798,000
OH	n/r	63,000	n/r	63,000	483,000
Oxalate	n/r	<1,160	30,700	<31,900	8.12
Pb	n/r	169	<333	<502	817
P as PO_4	n/r	5,210	19,500	24,700	26,200
S as SO_4	n/r	2,020	37,900	39,900	81,100
Sb	n/r	<51.1	<175	<226	n/r
Se	n/r	<85.1	<294	<379	n/r
Si	1,260	212	1,100	2,570	6,530
Sm	n/r	<85.1	<292	<377	n/r
Sr	n/r	<8.51	<29.3	<37.8	0.0
Ti	n/r	<8.51	<29.2	<37.7	n/r
Tl	n/r	<170	<584	<754	n/r
TOC	n/r	5,230	14,400	19,600	63,903
U	n/r	<425	1,180	<1,600	5,860
V	n/r	<42.6	<146	<189	n/r
Zn	n/r	13.8	58.4	72.1	n/r
Zr	n/r	<8.85	79.6	<88.4	42.3

Table D3-5. Estimated Chemical and Radionuclide Inventory for Tank 241-A-101. (3 Sheets)

Analyte	Sludge Layer Inventory (Ci)[1]	Drainable Liquid Inventory (Ci)[2]	Saltcake Inventory (Ci)[2]	Sample-Based 241-A-101 Inventory (Ci)	HDW Model Inventory (Ci)
^{241}Am	n/r	<0.606	<1,380	<1,380	197
^{137}Cs	2,050	606,600	641,000	1,250,000	866,000
^{60}Co	n/r	<22.4	<105	<127	145
^{154}Eu	n/r	<138	<328	<466	2,270
^{155}Eu	n/r	<592	<1,110	<1,700	961
$^{239/240}Pu$	n/r	<0.336	n/r	n/a	211
^{90}Sr	107,900	125	44,200	152,200	481,000

Notes:
[1]Based on the sludge composition in Table D3-4
[2]Based on the saltcake/drainable liquid compositions in Table D3-3
[3]Radionuclides decayed to January 1, 1994

D3.5 COMPARISON OF TANK 241-A-101 INVENTORY ESTIMATES

The tank 241-A-101 inventories predicted by the HDW model and the inventories based on core sample analyses are in excellent agreement for the major components (Al, Na and NO_3), and reasonably good for most other species.

Aluminum. The HDW model predicts an aluminum inventory which is only 8 percent less than that predicted from the analytical data.

Carbonate. The sample-based tank 241-A-101 carbonate inventory is 1.9 times the HDW model inventory. The hydroxide ion in Hanford Site waste tanks is converted to carbonate by the absorption of carbon dioxide from the ambient air. The one mole of absorbed carbon dioxide will react with two moles of hydroxide ion to form one mole of carbonate ion. The rate is difficult to model at best, and is accelerated by use of the airlift circulators that were installed in many Hanford Site underground storage tanks. The hydroxide concentration was not measured for the solids materials in the tank 241-A-101 core samples, so an overall hydroxide/carbonate comparison is not possible. However, conversion of the 44,300 kg of the hydroxide predicted by the HDW model to carbonate would account for differences in the carbonate inventories.

Fluoride. The HDW model fluoride inventory is 2.4 times that determined from the sample results. This may be the result of assuming too high a fluoride solubility in the tanks originally receiving wastes containing fluorides. Consequently, the fluoride concentration in the supernatants (which became evaporator feed) is overestimated by the HDW model.

Iron. The HDW model iron inventory is much higher than the inventory based on the 241-A-101 core samples. Part of this difference is the result of the HDW model assumption that the sludge heel after tank sluicing in 1976 was equivalent to PUREX HLW. The sludge heel was sampled in 1976 (Burch 1976) and the heel was found to include insoluble minerals that had formed in the tank waste.

Nitrate . The nitrate inventory predicted by the HDW model is only 3 percent less than the sample-based nitrate inventory.

Oxalate. The HDW model predicts essentially no oxalate in tank 241-A-101. The core sample analyses indicate that about 42 percent of the TOC inventory is actually present as oxalate. The oxalate was likely created by degradation of higher molecular-weight organic materials (radiolysis or hydrolysis), processes that are apparently not adequately accounted for in the HDW model.

Phosphate. The HDW model inventory for phosphate is only 6 percent higher than that determined from the core samples.

Sodium. The predicted HDW sodium inventory is only 3 percent lower than that calculated from the tank 241-A-101 core samples.

Sulfate. The HDW model sulfate inventory is twice that determined from the core sample analyses. The HDW model assumes a sodium sulfate solubility of 0.35*M*, which is not unreasonable for solutions with high sodium ion concentrations. The HDW model global sulfate inventory is less than that predicted by the standard inventory task (Kupfer et al. 1997). The HDW model has apparently incorrectly distributed sulfate to the evaporator feed during the production of the tank 241-A-101 salt slurry.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997). The revised total hydroxide inventory based on core sample analyses is 451,000 kg, which is 7% less than the HDW model estimate. Most of this difference results from the fact that the carbonate inventory calculated from the core sample analyses is significantly higher than the HDW model prediction.

Cesium-137 and Strontium-90. The heat load for tank 241-A-101 has been estimated at 18,379 Btu/hr (Chaffee 1995). This corresponds to a maximum of 806,000 Ci ^{90}Sr (0.0228 Btu/Ci ^{90}Sr) or a maximum of 1,141,000 Ci ^{137}Cs (0.0161 Btu/Ci ^{137}Cs). About 85 percent of the heat load appears to be the result of ^{137}Cs based on the sample-based ^{137}Cs inventory. The sample-based ^{90}Sr inventory would contribute an additional 3,080 Btu/hr. The combined best-basis ^{90}Sr and ^{137}Cs inventories would produce 28 percent more heat than estimated by Chaffee (1995).

The HDW model ^{90}Sr inventory is 3.2 times the sample-based inventory. The HDW model predicts that 73 percent of the ^{90}Sr is included in the salt slurry, so the HDW model assumption that the initial tank sludge heel was PUREX HLW does not account for this difference. One possible explanation is that the tank supernatants were often pumped out a few days after slurry receipt, and the solids containing ^{90}Sr may not have had time to settle. Another possibility is that the strontium was held in solution by dilute complexant concentrations, and similarly was pumped out with the supernatants. The HDW model ^{137}Cs inventory is 30 percent lower than the sample-based inventory.

Analytical Methods. All chemical analyses for the solid material in the two core samples were made on acid digested samples. Caustic fusion sample preparations were performed only for radionuclides. Caustic fusion sample preparation generally dissolves a larger fraction of relatively insoluble materials. The comparison of tank 241-A-101 analytical results with tank 241-A-103 (which included caustic fusion sample preparation) suggests that some minor components (Ca, Mg, Mn, Si, U, Zn and Zr) may be under-reported because the less rigorous acid digestion was used for sample preparation.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage.

Chemical and radiological inventory information are generally derived using three approaches: 1) component inventories are estimated using the results of sample analyses; 2) component inventories are predicted using the HDW model based on process knowledge and historical information; or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for tank 241-A-101 was performed using:

- Two core samples taken in July 1996 (Steen 1997).
- Waste transactions and operating data to confirm expected waste types.
- Comparison with composition data from two waste tanks (241-A-102 and 241-A-103) that are expected to have a similar SMMA1 salt compositions.
- An inventory estimate generated by the HDW model (Agnew et al. 1997a).

Based on this evaluation, a best-basis inventory was developed. The sample-based inventories were preferred in all cases. The HDW model inventories were used when analytical data was not available.

The waste in tank 241-A-101 consists primarily of saltcake and saturated liquid produced by the 241-A Evaporator (3,596 kL [950 kgal]). A small layer of sludge (approximately 11 kL [3 kgal]) with higher concentrations of silicon, iron and ^{90}Sr is also present. The best-basis inventory for tank 241-A-101 is presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am etc., were infrequently reported. For this reason it was necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997). Model generated values for radionuclides in any of 177 tanks are reported in Agnew et al. (1997). The best-basis value for any one analyte may be a model result, a sample, or an engineering assessment-based result if available. (No attempt was made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model). For a discussion of typical error between model-derived values and sample-derived values, see Kupfer et al. (1997, Section 6.1.10).

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-A-101, Effective May 31, 1997. (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	147,000	S	
Bi	<378	S	
Ca	<782	S	The saltcake inventory is 697 kg. Drainable liquid concentrations were less than detection limits.
Cl	24,100	S	
CO_3	169,000	S	
Cr	5,430	S	
F	<1,560	S	The saltcake inventory is 1,430 kg. Drainable liquid concentrations were less than detection limits.
Fe	1,390	S	
Hg	5.9	M	
K	25,800	S	
La	10	M/E	
Mn	<110	S	The saltcake inventory is 102 kg. Drainable liquid concentrations were less than detection limits.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-A-101, Effective May 31, 1997. (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Na	955,000	S	
Ni	<211	S	The saltcake inventory is 194 kg. Drainable liquid concentrations were less than detection limits.
NO_2	461,000	S	
NO_3	821,000	S	
OH_{TOTAL}	451,000	C	Total hydroxide estimated by charge balance.
Pb	<502	S	
P as PO_4	24,700	S	
Si	2,570	S	
S as SO_4	39,900	S	
Sr	<37.8	S	
TOC	19,600	S	
U_{TOTAL}	<1,600	S	The saltcake inventory is 1,180 kg. Drainable liquid concentrations were less than detection limits.
Zr	<88.4	S	The saltcake inventory is 79.6 kg. Drainable liquid concentrations were less than detection limits.

Notes:

[1]S = Sample-based (based on 1996 core samples, see Appendix B), M = HDW model-based, C = Calculated by charge balance, includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3, and E = Engineering assessment-based

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-A-101 Effective May 31, 1997 and Decayed to January 1, 1994. (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	731	M	
^{14}C	115	M	
^{59}Ni	7.16	M	
^{60}Co	<127	S	
^{63}Ni	703	M	
^{79}Se	11.9	M	
^{90}Sr	152,000	S	
^{90}Y	152,000	S/E	Based on ^{90}Sr analysis.
^{93}Zr	58.1	M	
^{93m}Nb	42.3	M	
^{99}Tc	869	M	
^{106}Ru	0.0256	M	
^{113m}Cd	308	M	
^{125}Sb	651	M	
^{126}Sn	18.0	M	
^{129}I	1.68	M	
^{134}Cs	12.6	M	
^{137}Cs	1,250,000	S	
^{137m}Ba	1,180,000	S/E	Based on ^{137}Cs analysis.
^{151}Sm	41,900	M	
^{152}Eu	16.1	M	
^{154}Eu	<466	S	
^{155}Eu	<1,700	S	
^{226}Ra	5.2E-04	M	
^{227}Ac	0.0032	M	
^{228}Ra	1.11	M	
^{229}Th	0.026	M	
^{231}Pa	0.014	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-A-101 Effective May 31, 1997 and Decayed to January 1, 1994. (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}Th	0.12	M	
^{232}U	3.38	M	
^{233}U	13.0	M	
^{234}U	2.19	M	
^{235}U	0.087	M	
^{236}U	0.070	M	
^{237}Np	3.0	M	
^{238}Pu	5.05	M	
^{238}U	3.0	M	
^{239}Pu	181	M	
^{240}Pu	30.6	M	
^{241}Am	197	M	
^{241}Pu	352	M	
^{242}Cm	0.54	M	
^{242}Pu	0.0019	M	
^{243}Am	0.0073	M	
^{243}Cm	0.049	M	
^{244}Cm	0.40	M	

Notes:

[1]S = Sample-based (based on 1996 core samples, see Appendix B), M = HDW model-based, E = Engineering assessment-based

D5.0 APPENDIX D REFERENCES

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